E09

Sensitivity Studies of Dynamic Strain-Based Damage Index for Seismic Fracture Detection

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1. Introduction

In this paper, the damage index developed by Kurata *el al*. [1] was further extended to obtain the relationship between the damage index and the remaining load-carrying capacity of fractured beams based on a sensitivity study with a numerical model.

2. Numerical simulation model

The numerical study was conducted using the finite element (FE) analysis software, MSC-Marc. Seismic fracture was introduced to one bem with seven damage extents each corresponding to different amounts of reduction in bending stiffness (Table 1). A set of sensors S1 to S8 were placed on one side of the bottom flange of a beam with the distance of 0.2*d*, 0.4*d*, 0.6*d*, 0.8*d*, 1.0*d*, 1.2*d*, 1.6*d*, 2.0*d* (*d* is the depth of beam) from a column surface respectively. The frame was excited with two excitations: (1) a white noise (WN); and (2) an earthquake ground motion (EM).

3. Analysis results

Figure 1 implied the independency of the damage index on the characteristics of external excitations and the selection of vibrational modes. However, as the extraction of modal responses required the pre-set band-pass filters, the use of dominant vibration modes with clear responses were highly desirable.

Figure 2 showed that the damage index extracted within the distance of 1.2*d* (*d* is beam depth) away from column surfaces was largely affected by local strain redistributions induced by fracture. Hence, in order to obtain a stable relation between damage index and reduction of bending stiffness, the distance between 1.2*d* and 2.0*d* (i.e. S6 to S8) is recommended for evaluating the damage extent of seismic fracture in steel moment-resisting frames.

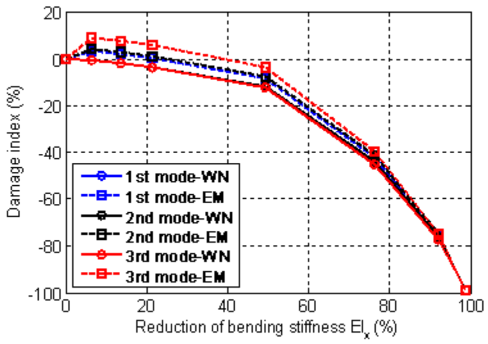


Figure 1. Damage index for different excitations and modes.

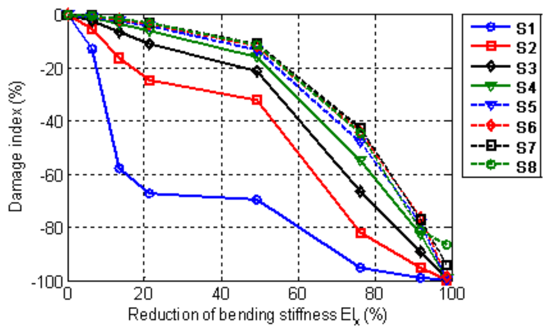
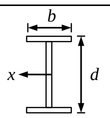
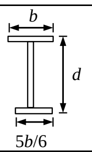
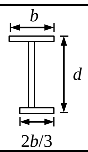
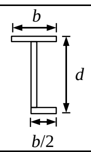
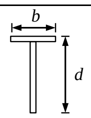
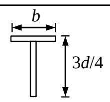
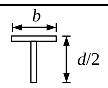
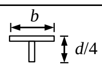


Figure 2. Damage index for different sensor locations.

4. Reference

1. Kurata M, Li X, Fujita K, Yamaguchi M. Piezoelectric dynamic strain monitoring for detecting local seismic damage in steel buildings. *Smart Materials and Structures* 2013; 22, 115002.

Table 1. Damage patterns for fracture simulation.

Pattern	**DP0**	**DP1**	**DP2**	**DP3**	**DP4**	**DP5**	**DP6**	**DP7**
Section								
EI_x decrease (%)	0	6.5	13.5	21.2	49.1	76.1	91.8	98.7